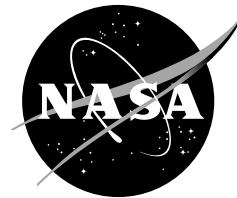


CVSRF Overview

Aviation Systems Division
Simulation Planning Office
Aerospace Simulation Operations Branch



NASA Ames Research Center

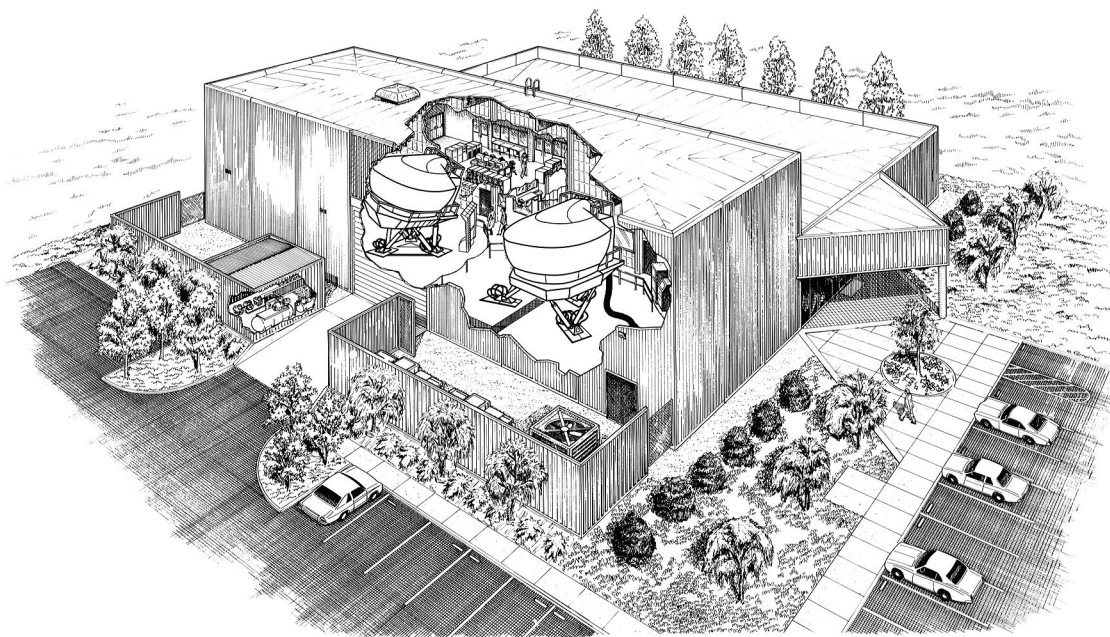
Crew-Vehicle Systems Research Facility

The Crew-Vehicle Systems Research Facility (CVSRF), a unique national research resource, was designed for the study of human factors in aviation safety. The facility is used to analyze performance characteristics of flight crews; formulate principles and design criteria for future aviation environments; evaluate new and contemporary air traffic control procedures; and develop new training and simulation techniques required by the continued technical evolution of flight systems.

Studies have shown that human error plays a part in 60 to 80 percent of all aviation accidents. The Crew-Vehicle Systems Research Facility allows scientists to study how errors are made, as well as the effects of automation, advanced instrumentation, and other factors, such as fatigue, on human performance in aircraft.

The facility includes two flight simulators—a Boeing 747-400 and an Advanced Concepts Flight Simulator (ACFS)—and a simulated Air Traffic Control (ATC) System.

Both flight simulators are capable of full-mission simulation. Each has a dedicated experimenter's control lab, capable of monitoring and controlling its simulator. Visual systems provide out-the-window cues in both cockpits. The Air Traffic Control System simulator provides a realistic air traffic control environment, including communication with the cockpits allowing study of air-to-ground communications systems as they impact crew performance.



Cut-away view of the Crew-Vehicle Systems Research Facility



Boeing 747-400 Simulator Cockpit

Simulators

Human Factors research requirements demand a facility capable of producing realistic simulation of both current and future aviation operations. The Boeing 747-400 simulator represents a current technology state-of-the-art glass cockpit aircraft. Rigorous control and high fidelity ensures that aircrew behavior in simulated flights is representative of actual flight operations.

In contrast, the Advanced Concepts Flight Simulator, configured with multiple electronic displays, advanced crew-aircraft interfaces and flight control devices, is designed to permit virtually unlimited flexibility in information presentation, and command and control by the aircrew. Such flexibility permits the simulation of operations that may be possible with advanced aircraft and air traffic control concepts and equipment of the future.

Both aircraft simulators can operate in conjunction with the facility's Air Traffic Control (ATC) Simulator. The ATC simulator can be configured to represent either today's aviation system or various possible systems of the future. Connection of either the aircraft or the ATC simulator with flight and air traffic control simulators at other facilities or locations is possible.

The research being performed in the CVSRF demands highly realistic external visual scene presentations in the aircraft cockpits. Both simulators are equipped with state of the art image generator computers and 180-degree field of view projection systems which provide an extremely realistic out-the-window representation. These systems use highly detailed databases identifying the visual features of numerous airports and routes throughout the world.

Boeing 747-400 Simulator

A key component of the facility is a Boeing 747-400 flight simulator. This simulator represents a cockpit of one of the most sophisticated airplanes flying today. The simulator is equipped with programmable flight displays that can be easily modified to create displays aimed at enhancing flight crew situational awareness and thus improving system safety. The simulator also has a fully digital control loading system, a six degree-of-freedom motion system, a digital sound and aural cues system and a fully integrated autoflight system which provides aircraft guidance and control. It is also equipped with a weather radar system simulation and a Flight Safety International VITAL VIII visual system. The visual system can depict out-the-window scenes in either day, dusk, night or twilight modes. The visual,

weather radar, and motion systems are tightly coupled simulating weather effects with a high degree of realism. The host computer driving the simulator is part of the IBM 6000 series of computers utilizing IBM's reduced instruction set computer (RISC) technology. An additional IBM 6000 computer is provided solely for the purpose of collecting and storing data in support of experiments.

The 747-400 simulator provides all modes of airplane operation from cockpit preflight to parking and shutdown at destination. The simulator flight crew compartment is a fully detailed replica of a current airline cockpit. All instruments, controls and switches operate as they do in the aircraft. All functional systems of the aircraft are simulated in accordance with aircraft data. To ensure simulator fidelity the 747-400 simulator is constantly maintained to the highest possible level of certification for airplane simulators as established by inspectors of the Federal Aviation Administration (FAA). This ensures credibility to the results of research programs conducted in the simulator.

Advanced Concepts Flight Simulator

Another key element of the facility is the Advanced Concepts Flight Simulator (ACFS). Like the B747-400 simulator, the ACFS is also equipped with a six degree-of-freedom motion system, programmable flight displays, digital sound and aural cueing system, and a Flight Safety International VITAL VIIIi visual system with a 180-degree field of view. The simulator systems provide an extremely realistic full mission environment. The ACFS is configured as a generic commercial transport aircraft employing many advanced flight systems as well as features existing in the newest aircraft being built today. Among its advanced flight systems, the ACFS includes touch sensitive electronic checklists, advanced graphical flight displays such as airport moving maps and graphical aircraft systems schematics, a flight management system linked to ATC, and a Head Up Display (HUD) guidance system. In addition, the ACFS utilizes sidestick controllers for aircraft control in the pitch and roll axes.

The ACFS generic aircraft was formulated and sized on the basis of projected user needs into the 21st century. This concept led to the design of a hypothetical aircraft with the following characteristics:

- Maximum gross weight 225,000 pounds
- 200 passenger capacity
- Twin engine; 41,000 pounds thrust each engine
- Speed: .78 Mach; range 2500 miles
- Two person flight crew
- All-electric airplane (no hydraulics)
- Fly-by-wire; active flight controls
- Relaxed static margin; load alleviation
- T-tail, low wing, supercritical airfoil
- Composites for primary and secondary structures
- High-density fuel



Advanced Concepts Flight Simulator Cockpit



Air Traffic Control Simulator

The Air Traffic Control (ATC) environment is a significant contributor to pilot workload and, therefore, to the performance of crews in flight. Full-mission simulation is greatly affected by the realism with which the ATC environment is modeled.

From the crew's standpoint, this environment consists of dynamically changing verbal or data-link messages, some addressed to or generated by the crew, others addressed to or generated by other aircraft flying in the immediate vicinity.

The ATC simulator is capable of operating in three modes: stand-alone, without participation by the rest of the facility; single-cab mode, with either the ACFS or the 747-400 participating in the study; and dual-cab mode, with both cabs participating.

Experimenter Facilities

Two experimenter stations are provided, one for each of the flight simulators. Each experimenter station contains a suite of computer graphic displays, keyboards and terminals for interacting with the simulation computers, status lights and emergency controls, communication systems and other equipment useful for controlling flight simulators and conducting simulation experiments.

Each experimenter's laboratory also contains an audio station so that experimenters may communicate with the simulator crews during an experiment or with observers

located "on-board." In addition to the main experimenter consoles, an experimenter (or observer) station is located aboard each of the flight simulators. Communicating with the Air Traffic Control simulator is possible from each of the experimenter stations.

Typical Experiments

The CVSRF supports NASA, FAA, and industry research programs, including the NASA Airspace Capacity Improvement Programs and the Aviation Safety Initiative. Recent research experiments conducted at the CVSRF include:

- Advanced Air Transportation Technology Free Flight utilizing advanced air to air data-link and communications to provide enhanced air traffic separation and decrease time enroute.
- Converging Approaches and Multiple Parallel Approaches studies by the FAA to improve capacity at airports with difficult airport approach conditions, especially in poor weather or reduced visibility conditions.
- Propulsion Controlled Aircraft studies to provide an aircraft crew with the capability to land safely with all hydraulic systems failed or malfunctioning.
- Taxi Navigation And Situation Awareness (T-NASA) utilizing a Head-Up Display and electronic airport Moving Map system to improve traffic flow on the airport surface in bad weather for greater safety and efficiency.

The facility is managed by personnel in the Aerospace Simulation Operations Branch within the Aviation Systems Division, part of the Aerospace Directorate at Ames Research Center.

For Further Information...

If you have any questions please call Tom Alderete, Chief of the Simulation Planning Office at (650) 604-3271 or Barry Sullivan, Chief of the Aerospace Simulation Operations Branch at (650) 604-6756.

Or, visit us on the NASA Ames Homepage on the Internet. Our URL is:

<http://www.simlabs.arc.nasa.gov/>